femora with no genicular spines; posterior metatarsi short, unarmed, all the pulvilli very large; no arolia between the tarsal claws.

Total length 42 mm.; length of body 32 mm.; length of tegmina 32 mm.; pronotum 10 × 14 mm.

Brazil (*C. Lindman*). One example only.

Type in the Stockholm Museum.

Panesthia froggatti, sp. n.

♀. Allied to *P. kheili*, Bol., and with almost identical pronotal structure, but tegmina and wings reduced to squamiform rudiments, their apices obliquely truncate. Outer margins of seventh abdominal tergite faintly crenulate, the apical tooth directed outwards as well as backwards; margin of supra-anal lamina dentate.

Total length 37 mm.; length of tegmina 7·2 mm.; pronotum 10 × 14 mm.

Solomon Islands (*W. W. Froggatt*).

Type in Oxford University Museum.

EXPLANATION OF PLATE I.

Fig. 1. Apex of abdomen of *Stylopyga proposita*, sp. n., ♂. Dorsal aspect.

Fig. 2. Apex of abdomen of *Stylopyga togoensis*, sp. n., ♂. Dorsal aspect. Note the large genital styles.

Fig. 3. *Euthyrrapha vittata*, sp. n., ♀. × 6.

Fig. 4. Left hind tibia and tarsus of *Nymphrytria mirabilis*, gen. et sp. n., ♀.

Fig. 5. Left mid tibia and tarsus (from below) of *Polyphaga platypoda*, sp. n., ♀.

Fig. 6. *a*, Left tegmen, *b*, Right wing of *Holocompsa capsoides*, sp. n., ♂.

II. — *The Classification of the Teleostean Fishes of the Order Ostariophysi.*—1. *Cyprinoidea.* By C. Tate Regan, M.A.

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[Plate II.]

The order Ostariophysi includes a number of types which are very divergent in form and appearance, but which agree in the possession of the remarkable Weberian mechanism,

forming a communication between the air-bladder and the internal ear *.

Each *ductus endolymphaticus* unites with its fellow and gives rise to a backwardly directed median diverticulum, the *sinus endolymphaticus*, lying in a cavity of the basioccipital which is roofed by laminar inward expansions of the exoccipitals. This cavity, the *cavum sinus imparis*, communicates anteriorly with the perilymph spaces surrounding the internal ear, and posteriorly, where its bony roof terminates, gives rise to a pair of lateral cavities, the *atria sinus imparis*. The wall of each *atrium* is partly membranous and is in part formed by two ossicles, *claustrum* and *scaphium*, which represent the supra-neural and neural arches of the first vertebra; a ligament connects the *scaphium* with the *tripus*, a triangular or triradiate bone mainly formed of the rib of the third vertebra, but in the Characiformes clearly including the parapophysis also; in the connecting ligament may appear the *intercalarium*, primarily representing the neural arch of the second vertebra. The air-bladder is typically divided into anterior and posterior portions; the former is supported by the *os suspensorium*, either the parapophysis or rib of the fourth vertebra, or perhaps both, and in its wall is inserted the posterior process of the *tripus*. The other portions of the *tripus* and the *intercalarium* lie in the cavity of the *saccus paravertebralis*, a membranous sac filled with a semigelatinous fluid; in the more generalized types this sac communicates anteriorly with the subdural lymph spaces of the cranium through a lateral occipital foramen at the side of the *foramen magnum*.

Sagemehl thought that the Ostariophysi were related to *Amia*, but there can be little doubt that they are allied to generalized Clupeoids such as the Elopidæ. The Characiformes are the least specialized of the Ostariophysi, and the absence of a splenial, the presence of an endochondral supraoccipital, the ossified mesocoracoid, the complete vertebral centra, without caudal intercentra, and the homocercal structure of the caudal fin show that they are far removed from *Amia* and are closely related to the Isospondyli.

The Ostariophysi may be divided into two well-marked suborders, Cyprinoidea and Siluroidea; the classification of the former is the subject of the present memoir. The

* On the Weberian mechanism of the Cyprinoidea see especially Sagemehl, Morph. Jahrb. x. 1885, p. 102; Sörensen, Vid. Selsk. Skr. Copenhagen, (6) vi. 1892, p. 131; Bridge and Haddon, Phil. Trans. clxxxiv. (B), 1893, p. 65; Bloch, Jenaisch. Zeitschr. xxxiv. 1900, p. 1.

Cyprinoids are malacopterous physostomes * with the pelvic fins, when present, abdominal; the head is naked and the body is usually scaly; the branchiostegals are few, 3–5. Parietal bones are present, either meeting in the middle line or separated by a fontanel, and an orbitosphenoid is always present; the metapterygoid and symplectic are well developed; most of the parapophyses are distinct from the centra (except in *Misgurnus*) and the anterior vertebræ remain separate, or only the centra of the second and third may unite; epipleurals and epineurals are present.

The suborder Cyprinoidea includes three well-marked divisions—Characiformes, Gymnotiformes, and Cypriniformes.

Division 1. Characiformes †.

Body deep or moderately elongate; dorsal and caudal fins well developed; pelvic fins present; usually an adipose fin. Mouth typically non-protractile; jaws usually toothed and maxillary rarely excluded from the gape. Upper and lower pharyngeals dentigerous, normally opposed. An opisthotic; posterior temporal fossæ well developed, with two or three posterior apertures. Hyopalatine and opercular bones all present; palatine firmly attached to pterygoid and mesopterygoid. Post-temporal forked. Air-bladder large, free, divided into two by a transverse constriction.

This group comprises several hundred species from the fresh waters of Central and South America and Africa; it corresponds to the family Characidæ or Characinidæ of authors ‡.

Family 1. Characidæ.

Præmaxillaries not much produced; maxillaries well developed. Teeth in jaws usually strong; palate sometimes toothed. Hyomandibular two-headed, the posterior head inserted in a groove of the pterotic, the anterior with flat or concave surface articulating with a flat or convex surface on the sphenotic; pterygoid narrowed posteriorly, immovably attached to quadrate or mesopterygoid. Orbito-sphenoid

* Many Cobitidæ and Homalopteridæ, with the air-bladder reduced and encapsuled, are physoclists.

† Sagemehl, Morph. Jahrb. x. 1885, p. 102, has written a valuable memoir on the cranial osteology. Gill, Proc. U.S. Nat. Mus. xviii. 1895, p. 205, gives a list of some other papers of lesser importance.

‡ *Cf.* Bouleng. Camb. Nat. Hist., Fish. p. 575 (1904), and Cat. Afr. Freshwater Fish. i. p. 174 (1909); Eigenmann, Reports Princeton Exped. Patagon. iii. Zool. pts. 3 (1909) & 4 (1910).

forming a sutural union with frontals. Hypocoracoids separate, often forming a pair of flat vertical laminæ which are apposed in the middle line; pectoral radials usually 4, compressed and somewhat elongate, articulating with a ridge on the hypercoracoid. Scales cycloid. Dorsal fin median or posterior, short or of moderate length.

Chiefly carnivorous fishes from the fresh waters of Central and South America and Africa.

The principal genera may be arranged thus :—

I. Præmaxillaries fixed, firmly attached to the mesethmoid; maxillaries usually movable, rarely adherent to præmaxillaries.

A. Abdomen not serrated.

1. Teeth on the palatines or pterygoids: American.

a. Anal fin short; no fontanel.

Lateral line present, running straight along middle of side; teeth in jaws conical, with canines; a band of teeth on each side of the palate; hypocoracoids not in contact. (*Erythrininæ*.) ..... *Erythrinus, Hoplias.*

Lateral line absent; teeth in jaws rather small, tricuspid; a few small teeth on each side of the palate; hypocoracoids forming vertical laminæ which are apposed in the middle line. (*Lebiasininæ*.) *Lebiasina, Piabucina.*

b. Anal fin long; lateral line more or less decurved; hypocoracoids forming median vertical laminæ; teeth in jaws conical, with canines.

A series of conical teeth on each pterygoid; base of pectoral fin rather short. (*Acestrorhamphinæ*.) ..... *Oligosarcus, Acestrorhamphus, Acestrorhynchus.*

Minute granular teeth on pterygoid and mesopterygoid; base of pectoral fin very long. (*Cynodontinæ*.)..... *Cynodon.*

2. Palate toothless; lateral line usually decurved; hypocoracoids forming median vertical laminæ.

a. Præmaxillary with a posterior toothed process lying between maxillary and pterygoid *; teeth conical, with canines: African. (*Sarcodacinæ*.) .... *Sarcodaces.*

b. Præmaxillary normal. (*Characinæ*.)

c. Mesethmoid very large ..... *Chalceus, Plethodectes, Pyrrhulina, Pogonocharax.*

β. Mesethmoid of moderate size.

Teeth usually in 2 to 4 series in the præmax-

* In *Sarcodaces*, as in many Characiformes with the snout produced, the pterygoids extend to the vomer below or internal to the palatines, which retain their lateral ethmoid attachment.

illaries, compressed, notched or denticulated ..... *Bryconæthiops* *, *Alestes* *, *Petersius* *, *Brycon*, *Chalcinus*, *Henochilus*, *Bryconops*, *Creagrutus*, *Deuterodon*, *Pseudochalceus*, *Crenuchus* †, *Scissor*, *Bramocharax*, *Tetragonopterus*, *Astyanax*, *Stichanodon* †, *Iguanodectes*, *Hemibrycon*, *Paragoniates*, *Gymnocharacinus*, *Diapoma*, *Corynopoma*, *Pseudocorynopoma*, *Stethaprion*, *Brachychalcinus*.

Teeth in 2 series in the præmaxillaries, the outer or both conical or subconical; anal of moderate length ..... *Salminus*, *Hystricodon*, *Agoniates*.

Teeth uniserial, compressed, serrated incisors; mouth small ..... *Chirodon*, *Odontostilbe*, *Piabuca*.

Teeth uniserial, compressed, pointed, notched or denticulated; mouth larger ..... *Aphiocharax*, *Mimagoniates*, *Leptagoniates*.

Teeth uniserial, conical, without canines; anal not very elongate ..... *Phoxinopsis*, *Ctenocharax*.

Teeth conical, with canines; anal fin very long ..... *Charax*, *Roeboides*, *Cynopotamus*.

B. Abdomen keeled and serrated, bearing a median series of sharp-edged bony plates with backwardly directed points: American. (*Serrasalmoninæ*.) ..... *Mylesinus*, *Pygocentrus*, *Pygopristis*, *Serrasalmo*, *Myletes*.

II. Præmaxillaries movable; maxillaries firmly united by suture with the præmaxillaries: African. (*Hydrocyoninæ*.) *Hydrocyon*.

The Characinæ correspond to about fourteen of Eigenmann's subfamilies; many of these are certainly natural groups, inasmuch as they include but a single genus or two or three closely related genera. *Iguanodectes*, *Gymnocharacinus*, *Diapoma*, *Corynopoma*, *Stichanodon*, and *Stethaprion* are apparently quite as near to *Tetragonopterus* and *Astyanax* as the latter are to *Brycon*, and, in my opinion, nothing is gained by making them the types of separate subfamilies.

Chalceus and *Plethodectes* are placed by Eigenmann in the Piabucininæ, which he distinguishes from the Tetragonopterinæ by the absence of fontanels, a character of very slight importance. In the Characiformes the presence of fontanels is probably sometimes a primitive feature, sometimes not; they have often become reduced or have disappeared or have not developed, especially in those forms with the upper surface of the head flattish and the occipital crest low.

* These genera are African, the other Characinæ American.

† Teeth uniserial, but these genera are apparently related to the genera with biserial teeth, after which they are placed.

Distichodus has fontanels, but *Nannocharax* has not; *Hemiodus* has fontanels, but *Parodon* has not; most species of *Alestes* have fontanels, but in *Alestes macrolepidotus* they are absent and the parietals are united by suture. I could give other examples, but these will suffice.

Chalceus has the mouth and dentition of *Brycon* and is certainly related to that genus; on the other hand, the large scales, the short anal fin, the flattish head, &c. suggest relationship to *Pyrrhulina*, which is confirmed by the large size of the mesethmoid bone and by the somewhat intermediate dentition of *Plethodectes*.

Another genus with the mouth and dentition of *Brycon* is *Chalcinus*, which differs chiefly in the keeled thorax and compressed abdomen; on this account Eigenmann associates it with *Gastropelecus*, but the skeleton is essentially similar to that of *Brycon*. *Pseudocorynopoma* differs rather markedly from *Chalcinus*, and appears to me more nearly related to *Astyanax*. In *Paragoniates* and *Leptagoniates* the keel of the thorax is evident, but the abdomen is not compressed to a sharp edge; these appear to me to be related to *Hemibrycon* and *Aphyocharax* respectively, whilst *Piabuca* may stand in the same relation to *Odontostilbe* that *Chalcinus* does to *Brycon*.

From the above remarks it will be evident that I do not regard Eigenmann's Gastropelecinæ and Agoniatinæ as natural groups, and the same may be said of his Characinæ, which includes three well-marked groups which are not specially related, viz. (1) *Bramocharax*, (2) *Salminus* and *Hystricodon*, and (3) *Charax*, *Roeboides*, and *Cynopotamus*.

Bramocharax is, in my opinion, closely related to *Scissor*; the latter is a *Tetragonopterus* with large mouth, produced snout, enlarged anterior teeth, and outer series of præmaxillary teeth reduced; *Bramocharax* seems to differ only in that the snout is longer, the enlarged anterior teeth are further apart, and the outer præmaxillary teeth are still smaller. *Salminus* and *Hystricodon* are closely related to *Brycon*, from which they differ only in the dentition; moreover, most of the teeth in *Salminus* are not truly conical, but approximate to the compressed and tricuspid type, especially in young specimens; *Agoniates* is known to me only from the description and figure of Müller and Troschel, but I believe that it will prove to be closely related to *Salminus*.

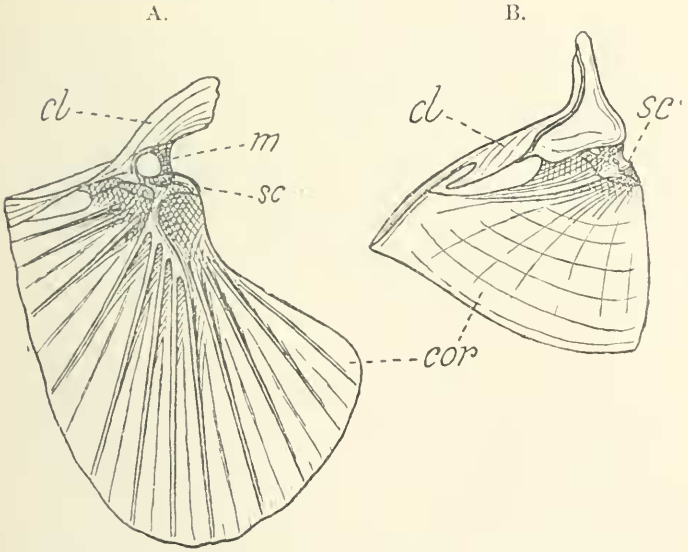
Charax, *Roeboides*, and *Cynopotamus*, with their exposed maxillary and long anal fin, show little resemblance to *Salminus*, but much to *Hemibrycon* and *Paragoniates*, to which they are probably rather closely related.

The African genus *Hydrocyon* has most of the characters of Characinæ such as *Alestes*, from which it differs especially in the structure of the mouth. The well-developed maxillary is firmly united by suture to the præmaxillary, and the latter is movably articulated with the ethmoid. The jaws are not much produced and the teeth are strong spaced canines; the mouth can be widely opened, and by pulling down the lower jaw the upper can be readily made to move in a vertical plane until the edge forms an angle of 50° with its position when the mouth is closed *.

Family 2. Gastropelecidæ.

The South-American genus *Gastropelecus* has usually been placed near *Chalcinus*, but I find that whilst the latter is

Fig. 1.



Cleithrum and primary pectoral arch (except radials) of A. *Gastropelecus pectorosus* and B. *Chalcinus trachypomus*.

cl, cleithrum; *cor*, hypocoracoid; *sc*, hypercoracoid (scapula); *m*, mesocoracoid.

extremely similar to *Brycon* in osteological characters, *Gastropelecus* is quite different. *Gastropelecus* is remarkable for its

* According to Boulenger (Cat. African Freshwater Fishes, i. p. 179) the præmaxillaries are "slightly movable vertically."

deep strongly compressed body, with the thorax and abdomen expanded into a sharp-edged semicircular disc; the pelvic fins are very small and the pectorals are long, with the rays very strongly branched, except the first, which is stout and simple. The pectoral arch is quite unique in structure; the hypocoracoids are ankylosed, forming a single bone, which is expanded below into a very large lamina that somewhat resembles a half-folded fan, the prominent radiating ridges of one side corresponding to the hollow grooves of the other; the radials are represented by a single short and broad bone, with a concavity fitting the broad convex articulating surface of the hypercoracoid.

In most other characters *Gastropelecus* is not unlike *Tetragonopterus*, except that there is no fontanel and rather prominent longitudinal ridges border the well-developed muciferous channels on the upper surface of the head.

Family 3. Xiphostomatidæ.

Osteological characters of the Characidæ, but the small maxillary is firmly united by suture with the very long præmaxillary and the upper jaw is somewhat movable. The snout is produced and the mouth is large, with the teeth in the jaws small, uniserial; a band of minute teeth is present on the pterygoid; the scales are ciliated, the lateral line, when present, runs along the middle of the side, and the dorsal and anal fins are short, posterior.

South American; carnivorous, pike-like fishes.

Xiphostoma, Luciocharax.

Family 4. Anostomidæ.

Upper jaw movable, the præmaxillaries articulating with a pair of antero-lateral sessile facets on the mesethmoid; maxillaries movably articulated with or adherent to the præmaxillaries. Teeth, when well developed, compressed incisors; palate toothless. Pterygoid rather broad posteriorly, overlapping the quadrate. Orbitosphenoid connecting alisphenoids and parasphenoid, nearly or entirely separated from the frontals. Dorsal fin median, short; scales cycloid or ciliated; lateral line straight.

These fishes are South American.

The genera may be arranged thus:—

1. Mouth small, non-protractile; lips thick. Præmaxillaries triangular; inner ends of maxillaries articulating with mesethmoid; rami of lower jaw short and stout. Quadrate firmly united to pterygoid and præoperculum (Pl. II. fig. 1); hyomandibular as in the Characidæ. (*Anostominæ.*)

A. Teeth well-developed in both jaws, uniserial, fixed incisors. . *Anostomus, Rhytiodus, Leporinus, Leporellus.*

B. Teeth very small, movable, labial, uniserial in both jaws, or in the upper only ..... *Cænotropus.*

II. Mouth wide, non-protractile; lips thin or absent; jaws toothless. Præmaxillaries expanded transversely, carrying the small maxillaries away from the mesethmoid; rami of lower jaw moderately long, their transverse anterior portions slender. Suspensorium as in the Anostominæ. (*Curimatinæ.*).. *Curimatus, Anodus.*

III. Mouth terminal, somewhat protractile, with thick lips concealing the maxillaries; teeth minute, labial. Præmaxillaries curved; rami of lower jaw short, but formed as in the Curimatinæ. Quadrate movably articulated with the pterygoid in front and the præopercle behind; mesopterygoid and metapterygoid firmly united by suture, but only loosely attached to the pterygoid and hyomandibular respectively (Pl. II. fig. 2); hyomandibular with a single head, fitting into a groove formed by the sphenotic and pterotic. (*Prochilodontinæ.*) ..... *Prochilodus.*

Family 5. Hemiodontidæ.

Præmaxillaries small, movably attached to the ethmoid; maxillaries well developed, articulated with or adherent to the præmaxillaries, their inner extremities articulating with the mesethmoid; mouth small, subterminal. Teeth uniserial, in both jaws or in the upper only; palate toothless. Pterygoid movably articulated with quadrate, narrowed posteriorly, ending in a small condyle; mesopterygoid firmly attached to pterygoid and loosely connected with quadrate (Pl. II. fig. 4). In other osteological characters essentially similar to the Characidæ. Dorsal fin short, median; anal short; scales cycloid; lateral line, when present, straight.

South American.

The principal genera may be arranged thus :—

I. Teeth fixed, conical or cuspidate, forming a single series in both jaws. Hyomandibular broad, two-headed. (*Nannostominæ.*) *Nannostomus, Characidium.*

II. Præmaxillaries with a single series of movable serrated incisors; lower jaw with a rather sharp transverse toothless edge anteriorly, with or without 2 or 3 small teeth laterally. Hyomandibular with a single head, fitting into a groove formed by the sphenotic and pterotic. (*Hemiodontinæ.*) .... *Hemiodon, Saccodon, Parodon.*

Family 6. Citharinidæ.

Upper jaw movable, the præmaxillaries articulated with a pair of antero-lateral apophyses of the mesethmoid; maxillaries articulated with or attached to præmaxillaries, their inner ends not reaching the mesethmoid. Teeth in jaws

usually compressed, often cuspidate; palate toothless. Hyomandibular with a single head fitting into a groove; pterygoid normally attached to quadrate. Orbitosphenoid forming a long sutural union with frontals. Dorsal fin median, often rather elongate; scales usually ciliated; lateral line, when present, straight.

This very natural group of African fishes corresponds to the Ichthyoborinæ, Distichodontinæ, and Citharininæ of Boulenger, after excluding from the latter the American genera *Curimatus* and *Prochilodus*.

In the following arrangement of the genera important differences in the structure of the lower jaw are for the first time taken into account :—

I. Rami of lower jaw widely separated for the greater part of their length, anteriorly slender and curved together, movably connected at the symphysis; dentary and articulare firmly united *.

Scales strongly ciliated; maxillary rather large, movably articulated with præmaxillary; upper jaw not or scarcely projecting beyond the lower; teeth small, bicuspid, in 2 or 3 series. (*Xenocharacinæ.*) ..... *Nannæthiops, Neolebias, Xenocharax.*

Scales strongly ciliated; maxillary united with præmaxillary; upper jaw strongly projecting, toothless anteriorly; teeth very small, bicuspid, uniserial. (*Hemistichodontinæ.*) ..... *Hemistichodus.*

Scales cycloid, or with the marginal teeth few and strong; maxillary small, adherent to præmaxillary; teeth minute, pointed or truncate, uniserial, on the labial margin. (*Citharininæ.*) ..... *Citharidium, Citharinus.*

II. Dentaries more or less massive, firmly connected at the symphysis, movably articulated with the articulares.

A. Mouth small, subterminal or inferior; lower jaw short, with the rather massive dentaries merely coalescent; maxillary well developed, adherent to præmaxillary; teeth small, bicuspid, in 1 or 2 series. (*Distichodontinæ.*).. *Distichodus, Nannocharax.*

B. Mouth terminal, rather large, the jaws produced; dentaries very massive, united by a long suture; præmaxillaries similar to the dentaries, with the reduced maxillaries united to them by suture. (*Ichthyoborinæ.*)

No canines; teeth biserial, the outer strong, compressed, bi- or tricuspid; maxillary entering the gape ..... *Eugnathichthys, Paraphago, Phago.*

* I find a well-developed angulare in *Citharinus*, as in other Characiformes.

Strong anterior canines; lateral teeth compressed, pointed, backwardly directed, uni- or bicuspid, uniserial, with or without minute inner teeth; præmaxillary decurved posteriorly, excluding the maxillary from the gape ..... *Ichthyoborus*, *Mesoborus*, *Neoborus*.

Division 2. Gymnotiformes*.

These Neotropical fishes differ from the Characiformes externally in the short præcaudal region and anterior vent, long tapering tail, with the anal fin much extended and the caudal reduced or absent, absence of dorsal and pelvic fins, and restricted gill-openings. The mouth is non-protractile and the maxillaries enter the gape. In cranial osteology the Gymnotiformes closely resemble the Characidæ, but the opisthotic is absent; palatine and pterygoid bones are absent, but the other members of the hyopalatine series are well developed (Pl. II. fig. 3), and the mesopterygoid forms an extensive union with the parasphenoid and vomer. The subopercular is reduced or absent. The post-temporal is simple; the coracoids show considerable differences in structure and development within the group. The vertebral column is similar to that of the Characiformes; the centra of the first four vertebræ remain distinct and the anterior ribs are inserted on autogenous parapophyses. The anterior and posterior divisions of the air-bladder are connected by a narrow duct†.

The principal characters of the families and subfamilies are shown in the following synopsis:—

I. Maxillaries well developed, larger than præmaxillaries. Hypocoracoid >-shaped, the slender lower fork running downwards and forwards to the cleithrum; pectoral radials 4. Anterior nostril superior; vent below the head; mouth usually small; dentition varied. Body scaly, compressed; no electric organs; orbitosphenoid and alisphenoids well developed.

A. Mesocoracoid well developed: lower limb of hypocoracoid meeting cleithrum near the symphysis; anterior part of air-bladder enclosed in a bony capsule: mouth toothless; maxillary articulated with distal end of præmaxillary; no caudal; no adipose fin ..... 1. *Rhamphichthyidæ*.

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* Eigenmann and Ward, Proc. Washington Acad. vii. 1905, p. 159, give a systematic account of the genera and species.

† Reinhardt, Arch. f. Naturg. 1854, p. 159.

B. No mesocoracoid; lower limb of hypocoracoid ending at edge of cleithrum far above the symphysis; air-bladder free; teeth, when present, small, pointed ..... 2. *Sternarchidæ*.

Maxillary with an apophysis articulating with a facet on head of vomer; caudal fin present; adipose fin represented by a long strip, lying in a groove on the back and attached anteriorly ..... 2 *a*. *Sternarchinæ*.

Maxillary not directly articulated with ethmoid or vomer; no caudal; no adipose fin ..... 2 *b*. *Sternopygināe*.

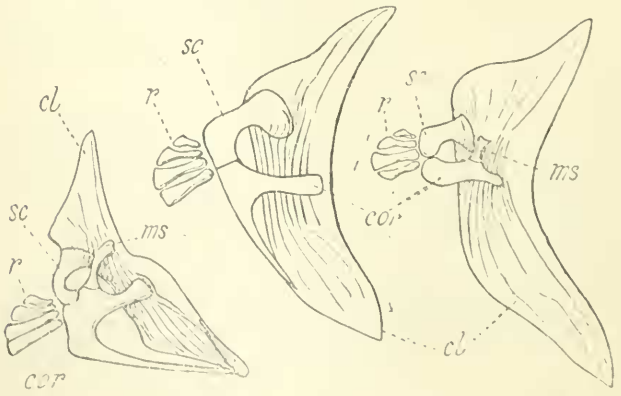
II. Maxillaries very small. Hypocoracoid a small lamina; mesocoracoid present, but very small; lowest pectoral radial shorter than the next. Anterior nostril labial; vent jugular; mouth moderate: teeth in jaws strong, uniserial; palate toothless. No caudal; no adipose fin.

A. Body scaly, compressed, moderately elongate; no electric organs; a small fontanel; orbitosphenoid and alisphenoids well developed, separating parasphenoid from frontals; 4 pectoral radials; vertebræ about 120..... 3. *Gymnotidæ*.

B. Body naked, not compressed, very elongate; large electric organs in the tail; no fontanel; orbitosphenoid and alisphenoids apparently suppressed, the parasphenoid extending upwards to the frontals; 7 or 8 pectoral radials; vertebræ about 250. 4. *Electrophoridæ*.

These Neotropical fishes have usually been placed in a single family, but I think that it will be readily admitted that the remarkable differences indicated above call for the recognition of at least four families.

Fig. 2.



Cleithrum and primary pectoral arch of A. *Rhamphichthys rostratus*, B. *Sternarchus albifrons*, and C. *Gymnotus carapo*.

cl, cleithrum; *sc*, hypercoracoid; *ms*, mesocoracoid; *cor*, hypocoracoid; *r*, radials.

Family 1. Rhamphichthyidæ.

The genus *Rhamphichthys* includes fishes with a produced snout and toothless mouth, mental vent and anal fin originating below or in advance of the eyes. The pectoral arch is more primitive in structure than in any other fishes of the group. The small capsule which contains the anterior portion of the air-bladder has a median aperture posteriorly, and there is on each side an antero-superior opening which receives the end of the *tripus*. The vertebræ are numerous (more than 140 in *R. rostratus*); the skull is very similar to that of *Sternopygus*, with the fontanel very large.

Family 2. Sternarchidæ.

The Sternarchinæ include the genera *Sternarchus*, *Sternarchogiton*, *Sternarchorhamphus*, and *Sternarchorhynchus*. In this subfamily the jaws are usually toothed, but the palate is toothless. I have examined the skeleton in *Sternarchus albifrons*, which has the skull smooth and rounded and the fontanel very small; the orbitosphenoid is paired, the two bones being separately united to the parasphenoid; the vertebræ number about 70.

I have satisfied myself by dissection that the pectoral arch is precisely similar in structure in *Sternarchus*, *Sternopygus*, and *Steatogenys*, differing from that of *Rhamphichthys* in the smaller size of the hypocoracoid and the absence of a mesocoracoid.

Sternopygus and *Steatogenys* agree together and differ from the Sternarchinæ in the absence of adipose and caudal fins and in the structure of the skull, the fontanel extending from supra-occipital to ethmoid, and of the mouth, a nodule of cartilage intervening between vomer and maxillary. In *Sternopygus* teeth are present in the jaws and on the mesopterygoids, in *Steatogenys* the mouth is toothless. These two genera, with the allied *Eigenmannia* and *Hypopomus*, constitute the subfamily Sternopyginæ. In *Sternopygus macrurus* there are more than 90 vertebræ.

Family 3. Gymnotidæ.

This family includes but a single species, *Gymnotus carapo* (*Carapus fasciatus*), in most of its characters nearer to *Electrophorus* than to the members of the preceding group. The skull approaches that of *Electrophorus* in general form; especially noteworthy is the curving upwards of the edges of

the parasphenoid, the breadth of the ethmoid, no doubt correlated with the strength of the præmaxillaries, and the very small fontanel between the supra-occipital and parietals.

Family 4. Electrophoridæ *.

This family also contains only one species, the electric eel, *Electrophorus electricus* (*Gymnotus electricus*), differing from the preceding in the characters of specialization enumerated in the synopsis.

Division 3. Cypriniformes.

Body deep or moderately elongate; dorsal and caudal fins well developed; pelvic fins usually present; no adipose fin. Mouth toothless, typically protractile. Opisthotic small or absent; posterior temporal fossa absent or variously developed, when present with a single posterior aperture. Lower pharyngeals typically falciform, not opposed to the toothless upper pharyngeals, but to paired posterior processes of the basioccipital, which may unite below the aorta. Hyopalatine and opercular bones all present; palatine movably articulated with mesopterygoid. Post-temporal simple.

Sagemehl (Morph. Jahrb. xvii. 1891, pp. 489–594, pls. xxviii. & xxix.) has given a detailed account of the cranial osteology of this group. The skeleton is very similar to that of the Characiformes, but there are some important differences.

In all the Cypriniformes the orbitosphenoid joins the alisphenoids behind, the lateral ethmoids in front, the frontals above, and the parasphenoid below. The palatine ends behind in a convex head which fits a concavity of the mesopterygoid; internally it articulates with the "septo-maxillaries," which are usually ossified and firmly united to the vomer, appearing as antero-lateral apophyses of that bone, but may remain as cartilages intervening between the vomer and palatine. The "septo-maxillary" and palatine articulate anteriorly with the maxillary, either directly or through the intervention of one or two pairs of "submaxillary" or "pre-palatine" cartilages (Catostomidæ) or bones (Cobitidæ, Homalopteridæ), which are more or less reduced in the Cyprinidæ.

The præmaxillaries have ascending pedicels which are attached to the extremity of a movable "rostral" bone; this is articulated with the vomer and is vertical when the

* On the electric organ, see Sachs, 'Untersuchungen am Zitteraal,' 1881.

præmaxillaries are retracted, horizontal when they are protruded.

The Cypriniformes correspond to the family Cyprinidæ of Günther, who, in 1868 (Cat. Fish. vii.), recognized four principal divisions, which have been accepted by all subsequent authors. These groups have sometimes been regarded as subfamilies, sometimes as separate families — Catostomidæ, Cyprinidæ, Cobitidæ, and Homalopteridæ.

Family 1. Catostomidæ.

Præmaxillaries small and maxillaries entering the gape; lips usually fleshy; no barbels. Pharyngeal teeth uniserial, often numerous; pharyngeal processes of basioccipital uniting below the dorsal aorta to form an expanded perforated lamella, rolled up at the edges, ending in a short blunt process, and not covered with a horny sheath. Mesethmoid broad, firmly united with frontals; subtemporal fossæ shallow; a large lateral occipital foramen on each side of the *foramen magnum*; paired fossæ present in the temporal region, open above and closed behind, but no posterior temporal fossæ. Cleithra normally suspended from supra-cleithra, much expanded transversely. Air-bladder large, free, divided into two or three parts by transverse constrictions. Outer ramus of *os suspensorium* strong, downwardly directed, with a transverse laminar expansion which meets its fellow; transverse process of second vertebra with a laminar expansion directed downwards and backwards, united by suture with the lamina of the *os suspensorium*.

Principal genera: *Carpiodes, Cycleptus, Catostomus, Xyrauchen, Moxostoma*, &c., with about sixty species from North America. *Myxocyprinus*, with two species from China, is related to *Carpiodes*.

Family 2. Cyprinidæ.

Præmaxillaries excluding maxillaries from gape; one or two pairs of barbels or none. Pharyngeal teeth, when present, in one, two, or three series, not more than seven in one series; pharyngeal processes of basioccipital typically united below the aorta to form a horizontal or oblique plate, flattish or concave below, supporting a horny pad *, and produced backwards into a strong process for the attachment of the *retractor* muscles of the lower pharyngeals. Mesethmoid broad, firmly

* On the structure of this horny pad, see Gratzianow, Zool. Anz. xxiii. 1900, p. 66.

united with frontals; subtemporal fossæ very deep; no temporal depressions, but supra-temporal fossæ more or less distinct, open behind, roofed by the post-temporal and sometimes by the pterotic and parietal. Cleithra normally suspended from supra-cleithra. Air-bladder divided into two parts by a constriction, typically large and free, but sometimes reduced (*Discoguathus*, *Gyrinochilus*), or the anterior part sometimes enclosed in a bony capsule formed by the *ossa suspensoria* (*Rhinogobio*, *Saurogobio*). Outer ramus of *os suspensorium* not connected with its fellow nor with the transverse process of second vertebra.

A fontanel is usually absent, but in *Saurogobio* it extends from the supra-occipital to the ethmoid, except for the frontal bridge. The capsule enclosing the anterior part of the air-bladder in *Rhinogobio* is quite remote from the transverse processes of the second vertebra and is widely open behind. In *Saurogobio* the posterior aperture is reduced and there are lateral expansions with terminal orifices which bear some resemblance to those of the Cobitidæ; in this case, however, the transverse processes of the second vertebra are free except near their base, where they support the lateral expansions, and the cavities of the latter do not communicate with that of the capsule and apparently contain diverticula of the paravertebral sacs.

There are probably at least 1000 species known from North America, Eurasia, and Africa.

A satisfactory classification of the genera cannot be arrived at without monographing the family, but the following remarks may not be out of place.

The greatest variety of genera and species is found in Asia, which may be regarded as the original home of the group; and of all the genera which I have examined *Opsariichthys* seems to be the most primitive. The terminal mouth, wide gill-openings, large pseudobranchiæ, median dorsal fin, rounded abdomen, triserial pharyngeal teeth, complete series of circumorbitals, large posterior temporal fossæ, and separate second and third vertebræ are all features of generalization. The foramen between quadrate and metapterygoid, so characteristic of the Characiformes, is well developed in *Opsariichthys*; this foramen is also present in *Chela*, but is absent in all other Cyprinids. In *Opsariichthys* the cleithra are formed much as in typical Characiformes, narrowing forwards to a point; many other genera with strongly decurved lateral line—*Barilius*, *Danio*, &c.—agree with *Opsariichthys* in the form of the cleithra, rounded or pointed anteriorly, and these are connected by genera such as *Aspius* with *Leuciscus*

and its allies, in which the cleithra are more expanded and truncated anteriorly; all the American genera seem to be Leuciscines, and *Alburnus* and *Abramis* also pertain to this group, to which *Rhodeus* is nearly related; the *Barbus* group differs in that the cleithra are distinctly emarginate anteriorly.

These characters are not sufficiently well marked for the definition of subfamilies, and others, such as the pharyngeal dentition, the form of the pharyngeal process, &c., are of use only in defining genera or small groups of genera.

Günther's Cyprinina seems to be a natural group, after excluding the North-American genera, but to it should be added *Rohteichthys* and *Osteobrama*, with the osteological characters of *Barbus*, and doubtless *Leptobarbus* and *Mystacoleucus* also; *Tinca* seems to be nearer to *Barbus* than to *Leuciscus*. The Rasborina and Danionina should be united and some of the Abramidina should be added to this group, some to the Leuciscina. *Xenocypris* is a Leuciscine, and the aberrant *Semiplotus* is, perhaps, nearest to it. *Hypophthalmichthys* is nearly related to the *Barilius* group.

Thanks to the kindness of Mlle. Dr. C. L. Popta, I have been able to examine a specimen of the remarkable Bornean Cyprinid, *Gyrinochilus pustulosus*, Vaill. This fish is evidently closely related to *Discognathus*, which it resembles in form, scaling, structure, and position of the fins, structure of the air-bladder, inferior mouth with the united lips expanded and papillose, and even in the groove on the snout and the disposition of the tubercles on the head. *Gyrinochilus* differs externally from *Discognathus* especially in the much broader lips, folded when retracted and when expanded recalling the suctorial disc of *Petromyzon*, and in the structure of the gill-opening, the upper part of which forms an inhalent orifice, the opercular membrane being curved inwards in front of the pectoral arch in this region. As described and figured by Vaillant, each branchial arch has a double series of gill-rakers developed along the upper edge of the gill, filtering the inhalent current of water. Internally *Gyrinochilus* is remarkable chiefly for the very long and much convoluted intestine, the slender toothless lower pharyngeals, the absence of a horny pad, and the reduction of the pharyngeal processes of the basioccipital to a pair of short blunt projections, much as in some Cobitidæ and Homalopteridæ.

Extraordinarily aberrant as *Gyrinochilus* is, its place in the system seems to be in the family Cyprinidæ next to *Crossochilus* and *Discognathus*; to make it the type of a

separate family or subfamily would merely obscure its relationships *.

Some of the more typical genera are grouped in the following list:—*Opsariichthys, Chela*; *Barilius, Bola, Aspidoparia, Danio, Nematabramis, Rasbora, Luciosoma, Nuria, Amblypharyngodon, Aspius, Scombrocypris, Chanodichthys, Pelecus, Culter*; *Hypophthalmichthys*; *Leuciscus, Squaliobarbus, Xenocypris, Ctenopharyngodon, Chondrostoma, Orthodon, Campostoma, Hybognathus, Cochlognathus, Hybopsis, Exoglossum*; *Alburnus, Abramis*; *Semiplotus*; *Rhodeus, Acanthorhodeus, Achilognathus*; *Cyprinus, Carassius, Barbus, Cosmochilus, Leptobarbus, Rohteichthys, Osteobrama, Varicorhinus, Gymnostomus, Psilorhynchus, Scaphiodon, Thynnichthys, Albulichthys, Labeo, Barbichthys, Dangila, Cirrhina, Osteochilus, Catla, Crossochilus, Discognathus, Gyrinochilus, Tinca, Aulopyge, Rhynchocypris, Pseudorasbora*; *Luciobrama*; *Oreinus, Schizothorax, Diptychus, Gymnocypris, Ptychobarbus, Schizopygopsis*; *Hemibarbus, Acanthogobio, Gobio, Pseudogobio, Leucogobio, Rhinogobio, Saurogobio.*

Family 3. Cobitidæ.

Præmaxillaries excluding maxillaries from gape; three pairs of barbels or more. Pharyngeal teeth uniserial, often rather numerous, on the inner and posterior edges of subtriangular laminar expansions of the pharyngeal bones, which are scarcely falciform; pharyngeal processes of basioccipital sometimes very small, sometimes larger and meeting below the aorta, but never united and not supporting a horny pad. Subtemporal fossæ shallow; a lateral occipital foramen on each side of the *foramen magnum*. Præorbital and suborbitals unossified. Cleithra normally suspended from supracleithra. Posterior part of air-bladder small or vestigial; anterior part enclosed in a bony capsule, produced outwards on each side into an expansion with terminal orifice, connected by a duct with the skin above the pectoral fin; anterior wall of lateral expansion of air-bladder capsule formed by the transverse process of the second vertebra.

The numerous species of this family are chiefly inhabitants of mountain streams in tropical and temperate Asia. Three species are European and one is found in Abyssinia.

* Since writing the above I note that Mlle. Popta (Notes Leyden Mus. xxvii. 1906, p. 122) has described from Borneo *Paracrossochilus bicornis*, a fish in many ways nearer to *Gyrinochilus* than either *Crossochilus* or *Discognathus*, the lips folding in a similar manner when the mouth is shut.

The principal genera may be arranged thus * :—

I. Mesethmoid firmly united to frontals; skull depressed; anterior part of air-bladder nearly divided into two, the lateral halves of the capsule connected only by a narrow bridge; no spine; barbels 6 or 8. (*Nemachilinæ.*) ..... *Nemachilus, Diplophysa, Oreonectes, Lefua.*

II. Mesethmoid movably articulated with frontals; skull compressed; air-bladder undivided, the central portion of the capsule subspherical. (*Cobitidinæ.*)

A. No spine; 10 or 12 barbels; parapophyses ankylosed with centra. *Misgurnus.*

B. Lateral ethmoid a movable spine; 6 or 8 barbels; parapophyses distinct from centra ..... *Botia, Parabotia, Leptobotia, Acanthopsis, Cobitis, Lepidocephalichthys, Jerdonia, Acanthophthalmus, Lepidocephalus, Eucirrichthys, Apua.*

Family 4. Homalopteridæ.

Præmaxillaries excluding maxillaries from gape; three pairs of barbels or more. Pharyngeal teeth uniserial, often rather numerous; lower pharyngeals falciform; pharyngeal processes of basioccipital very small or absent; no horny pharyngeal pad. Skull depressed; mesethmoid broad, firmly united to frontals: subtemporal fossæ deep; lateral occipital foramina absent. Suborbitals ossified and præorbital large, extending forward to the end of the snout, supported by an anterior process of the lateral ethmoid. Cleithra directly attached to epiotics, expanded below to form horizontal laminæ. Air-bladder reduced, completely divided into two lateral portions, each enclosed in a capsule formed by the *os suspensorium* and the transverse process of the second vertebra; each capsule with a lateral orifice beneath the skin and with an extended facet for articulation with the cleithrum.

This well-marked family includes a number of species from Southern Asia, which are readily distinguished by the numerous barbels, the subterminal or inferior mouth, the flattish lower surface, and the horizontal paired fins with the anterior rays simple, graduated.

Genera: *Homaloptera, Lepturichthys* †, *Helgia, Balitora,*

* *Cf.* Vaillant, Notes Leyden Mus. xxiv. 1902, p. 133, for a synopsis of the genera.

† *Lepturichthys*, gen. nov., type *Homaloptera fimbriatum*, Günth., differs from *Homaloptera* in the long slender tail, with a dorsal and ventral series of plates, which are probably expansions of the neural and hæmal spines.

Octonema, *Glaniopsis*, *Parahomaloptera*, *Crossostoma*, *Hemimyzon* *, *Gastromyzon* (*cf.* Vaillant, Notes Leyden Mus. xxiv. 1902, p. 110).

EXPLANATION OF PLATE II.

Fig. 1. Hyopalatine and opercular bones of *Leporinus frederici*.
Fig. 2. Ditto of *Prochilodus lineatus*.
Fig. 3. Ditto of *Sternopygus macrurus*.
Fig. 4. Ditto of *Hemiodus kappleri*.

p, frontal process of mesopterygoid; *pal*, palatine; *pt*, pterygoid; *q*, quadrate; *ms*, mesopterygoid; *mt*, metapterygoid; *hy*, hyomandibular; *sy*, symplectic; *pop*, præoperculum; *op*, operculum; *sop*, subopercuhum; *iop*, interoperculum.

III.—*Some Records of Collembola new to England, with Description of a new Species of* Oncopodura.

By John W. Shoebotham, N.D.A.

(From the Cooper Laboratory for Economic Research, Watford, Herts.)

[Plate III.]

During the last two and a half years the author has made collections of Collembola from several districts in England, but chiefly from the counties of Hertfordshire, Buckinghamshire, and Staffordshire. A list of the Hertfordshire Collembola was published last year †, since when additional forms have been found. Several species have been found which prove to be new to the English fauna, including a hitherto undescribed form. These records, with references to the original descriptions of the species, are given in the following paper.

Order COLLEMBOLA, Lubb.

Suborder Arthropleona, Börn.

Family Achorutidæ, Börn.

Subfamily *Achorutinæ*, Börn.

Genus Achorutes, Templ., Lubb.

1. *Achorutes serratus*, Ågr.

Achorutes serratus, Ågren, (1904) pp. 5, 6, pl. i. figs. 5–7.

Loc. Staffordshire.

Identification confirmed by Dr. Ågren.

* *Hemimyzon*, gen. nov., type *Homaloptera formosanum*, Boulenq., pelvic fins 15- or 16-rayed, with extended bases convergent posteriorly, approximating to the *Gastromyzon* structure.

† Collinge, W. E., and Shoebotham, J. W., "The Apterygota of Hertfordshire," Journ. Econ. Biol. vol. v. pt. 3, pp. 95–132, figs. 1–15 (1910).